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MARYLAND WATER SUPPLY AND DEMAND STUDY

Part II
FUTURE WATER SUPPLY AND DEMAND

Volume 2
A SUMMARY STATEMENT

Prepared for
MARYLAND STATE PLANNING DEPARTMENT

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MARYLAND WATER SUPPLY AND DEMAND STUDY

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Many of these choices, however, require careful planning and the spending of large sums of money. It is therefore important that such choices be based on careful projections and analysis of relevant economic and demographic magnitudes. The purpose of this report is to outline the broad picture of Maryland's water resource situation during the next forty-five years and to indicate choices and directions for public and private policy.

B. Population and employment projections

The first step in the analysis is to project Maryland's population and employment during the coming decades. For this and other purposes, the State was divided into five relatively homogeneous sub-regions. They are:

I - Southern Maryland: Calvert, Charles, St. Mary's Counties

II - Western Maryland: Allegany, Frederick, Garrett, Washington Counties

III - Baltimore Region: Baltimore City and Anne Arundel, Baltimore, Harford, Howard Counties

IV - Washington Region: Montgomery, Prince George's Counties

V - Eastern Shore: Caroline, Cecil, Dorchester, Kent, Queen Anne's, Somerset, Talbot, Wicomico, Worcester Counties

The projected future population of Maryland and the five sub-regions is shown in Table 1.* These projections imply that Maryland's population will continue to grow at a rapid rate relative to the national average, but a good deal less rapidly than it has during the last twenty-five years. Thus, from 32 percent between 1950 and 1960, the rate of growth is predicted to fall to 22 percent from 1960 to 1970, declining gradually to 15 percent from 2000 to 2010. The projections imply a 2010 population 2.4 times its 1960

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* For alternative high and low projections of all major magnitudes, see the parent report.

TABLE 1

Maryland Population Projections (000)
By Sub-Regions, Actual 1960; Projected 1970-2010

Region	1960	1970	1980	1990	2000	2010
			Medium			
I - Southern Md.	87	111	138	175	220	262
II - Western Md.	268	282	310	357	421	497
III - Baltimore Metro.	1,804	2,113	2,542	2,952	3,457	3,967
IV - Washington Metro.	698	1,023	1,320	1,634	1,974	2,265
V - Eastern Shore	244	271	313	356	408	464
Maryland	3,101	3,799	4,623	5,474	6,481	7,453

level. Maryland's population will continue to be heavily concentrated in the Baltimore and Washington metropolitan areas, rising from about 80 percent of the total in 1960 to 84 percent in 2010.

Maryland's employment is projected to grow somewhat less rapidly than its population since an increasing proportion of Maryland residents will work outside the State, mainly in Washington, in the coming decades.

Our projections of employment are shown in Table 2. These projections are consistent with recent state and national trends in labor force participation rates. They assume that unemployment will fall gradually to about 4 percent of the labor force in all regions.

Since water use is heavily concentrated in agriculture and certain public utility and manufacturing industries, it is important to have a detailed breakdown of employment projections by industry for the purpose of this report. Tables in the parent report indicate that the percentage of total employment will decline steadily in manufacturing, agricutlure, utilities and mining, whereas the percentage will rise in retail and wholesale

TABLE 2

Projections of Total Employment by Place of Employment For Maryland and Sub-Regions, Projected 1970-2010

(000)

Region	1970	1980	2010
	Medium		
I - Southern Md.	30	39	88
II - Western Md.	93	104	176
III - Baltimore Metro.	786	950	1,488
IV - Washington Metro.	304	403	723
V - Eastern Shore	99	116	179
Maryland	1,313	1,613	2,654

trade, services and government. Within the manufacturing sector, water use and waste production are concentrated in a small number of industries such as food processing, pulp and paper, chemicals, petroleum and metals. The parent report shows projections of employment by region for each of the twenty two-digit manufacturing industries.

C. Water use projections

In analyzing water use, it is very important to distinguish carefully between withdrawal and consumptive uses. Withdrawal uses occur when man removes water from the ground or from a lake, stream or other natural body. Consumptive uses occur if the water is not returned to the place from which it was withdrawn or if it is returned but changes in the time, place or quality of the return make further use impossible or prohibitively expensive. If water is used for irrigation, then the part which evaporates is clearly consumptive. If water is withdrawn from a fresh water stream and discharged into a brackish bay, then the use is consumptive on the above definition since the water has undergone serious deterioration in quality. Discharge of fresh water into salt or brackish bodies is the major consumptive use in Maryland.

A second major distinction that must be kept in mind is that between withdrawals from fresh and salt or brackish sources. Many industrial water needs, such as cooling, can be served by either fresh or brackish water. As clean fresh water has become relatively scarce in recent years, the use of brackish water by industry has grown rapidly. Although this report is concerned only with fresh water, the substitutability of fresh and brackish water for many purposes cannot be ignored. Furthermore, Chesapeake Bay and its reaches are perhaps Maryland's most unique natural resource and the use of these waters for purposes of industry, navigation and recreation deserves careful planning.

A final distinction is that between on-site and withdrawal uses. Water is used on-site for navigation, recreation, hydro-electric generation and the disposal of human and industrial wastes. Streamflow must be sufficient not only to meet consumptive uses but also to meet on-site requirements. In Maryland the constraining on-site use is for waste disposal, and streamflow requirements for this purpose are discussed in the next section. This section is devoted to consumptive uses.

One of the major tasks of the project was to estimate current withdrawals and consumption of fresh water in each of Maryland's regions and to project their future levels. These estimates and projections were made for each of the major categories of water users - household, commercial, institutional and municipal users; industry; agriculture; recreation; and thermal electric generation.

The estimates and projections of fresh water consumption are shown in Tables 3 and 4.

According to Table 3, Maryland's average daily water consumption was nearly 600 million gallons per day in 1960. Most of that consumption occurred in the State's two major metropolitan regions. In these regions, consumption is nearly as large as withdrawals, since most discharges are to brackish bodies. It can also be seen from the table that almost all of Maryland's fresh water consumption is by industry and the users of municipally supplied water. Agriculture is a small but rapidly growing user. Recreational consumption is negligible, since most recreational use of water is on-site. Almost the only recreational consumption of water results from its use in swimming pools. Thermal electric consumption of fresh water is of minor importance since most of Maryland's generating capacity is located on tidal waters.

Water consumption will grow rapidly during the coming decades in Maryland and in the country as a whole. We project that fresh water consumption will rise to over 800 million gallons per day in 1970, an increase of about one-third over 1960. By 2010, average daily consumption in Maryland will be 2,500 million gallons per day, four times the 1960 level. By 2010, fresh water consumption will be only slightly less concentrated in the Baltimore and Washington metropolitan areas than it was in 1960. By 2010, industry's proportion of total fresh water consumption will have fallen somewhat. Consumption will be more heavily concentrated in municipal uses and agriculture than in 1960. Industry is likely to continue the current trend toward the use of brackish water for many purposes. Therefore, the modest growth of industrial fresh water consumption projected in the tables fails to indicate

TABLE 3

Estimated Water Consumption in Maryland, 1960

(000 Gallons Per Day)

Region	Industry	Agriculture	Household, Commercial, Municipal	Recreation	Thermal Electric	Total
I - Southern Md.	841	308	5,328	75	-	6,552
II - Western Md.	3,668	4,067	6,793	180	1,595	16,303
III - Baltimore Metro.	240,274	-	145,662	-	-	385,936
IV - Washington Metro.	6,058	-	112,831	-	4,737	123,626
V - Eastern Shore	16,477	14,674	33,954	300	-	65,405
Maryland	267,318	19,049	304,568	555	6,332	597,822

TABLE 4

Projected Water Consumption in Maryland, Medium Level

(000 Gallons Per Day)

Region	Industry	Agriculture	Household, Commercial, Municipal	Recreation	Thermal Electric	Total
			1970			
I - Southern Md.	4,401	1,934	8,619	108	-	15,062
II - Western Md.	4,149	8,541	8,627	205	1,652	23,174
III - Baltimore Metro.	308,698	-	176,886	-	-	485,584
IV - Washington Metro.	26,232	-	172,538	-	5,507	204,277
V - Eastern Shore	27,581	37,859	40,170	339	-	105,949
Maryland	371,061	48,334	406,840	652	7,159	834,046
			1980			
I - Southern Md.	5,899	13,849	14,417	162	-	34,327
II - Western Md.	4,869	17,922	10,623	270	1,748	35,432
III - Baltimore Metro.	382,386	-	287,380	-	-	669,766
IV - Washington Metro.	37,631	-	250,319	-	5,562	293,512
V - Eastern Shore	34,573	89,610	53,490	470	-	178,143
Maryland	465,358	121,381	616,229	902	7,310	1,211,180
			2010			
I - Southern Md.	12,220	14,664	55,789	416	-	83,089
II - Western Md.	7,415	19,552	28,174	525	2,301	57,967
III - Baltimore Metro.	529,870	-	838,269	-	-	1,368,139
IV - Washington Metro.	49,500	-	601,559	-	6,904	657,963
V - Eastern Shore	54,123	162,927	117,115	967	-	335,132
Maryland	653,128	197,143	1,640,906	1,908	9,205	2,502,290

the importance of water to the future growth of Maryland industry. The availability of almost unlimited supplies of brackish water will be a major factor in Maryland's industrial growth during the coming decades.

The large proportionate increase projected for agricultural water consumption reflects the rapid current and future growth of supplementary irrigation in Maryland (especially on the Eastern Shore) and the large proportion of irrigation water that is consumed.

In summary, the use of water will grow rapidly in Maryland during the coming decades, as it will in most of the country. Maryland is more plentifully endowed with fresh and, especially, brackish water than most of the country and availability will be an important factor in attracting water users to the State. It is therefore of great importance that the development and use of this valuable resource be planned carefully in order to avoid misuse and quality deterioration through pollution.

D. Water requirements in streams to control quality

Water serves an important function in diluting, purifying, and carrying off the wastes produced by a modern society. Most wastes collected in municipal sewage systems are treated to remove at least three-fourths of the organic content; many industries also treat wastes and discharge only a fraction of the polluting matter produced. Yet the fraction discharged is a large amount, and projected growth in population and industry mean a growing volume of waste discharges, even though the overall rate of treatment is expected to rise.

The most widespread (and the cheapest) way of disposing of after-treatment wastes is by discharging them to streams to be diluted, further reduced in amount by the oxygen in the water, and carried away ultimately to river estuaries, the Chesapeake Bay, and the ocean. Some water must flow in the streams to maintain the quality standards set by society in the regions of the State where treated wastes cannot all be discharged directly to salt or brackish water bodies. In Table 5 we present our estimates of streamflow requirements for Regions II, III and IV under various assumptions as to the amount of treatment to be given wastes before discharge, and the level of quality desired in streams (measured in parts per million of dissolved oxygen). In Regions I and V we expect that virtually all wastes after treatment will be discharged to estuaries, bay, or ocean; large parts of the wastes from the Baltimore and Washington, D.C. metropolitan areas will also be discharged, after treatment, to non-fresh bodies of water. Studies now under way may show that effects in the estuaries and bay cannot be ignored; we do not deal with these bodies in this report. In the parent study we do discuss in some detail the numerous assumptions which were made in deriving the projections of Table 5.

E. The supply of water

Water surrounds man, as vapor in the atmosphere, as precipitation onto the earth, in flowing streams, in lakes, under the ground, and in the oceans. Yet at any one time only a small portion of this resource can be considered available for man's use - and that portion may be used several times before it passes out of his hands.

The water available most easily and at lowest cost is that flowing in streams; but since the level of stream flow changes from day to day, and from month to month, any measure of supply must take variation into account. Although the mean daily flow is the maximum available under complete regulation of streams, in unregulated or partly regulated streams it is not to be

TABLE 5

Streamflows Required to Maintain Quality, Regions II, III, and IV, Projected 1970-2010

(in millions of gallons per day)

Date - Treatment Level Quality Standard	Region II - Western Maryland				Region III	Region IV
	N. of Potomac	S. of Potomac	Potomac Mainstem	Ohio Basin	Baltimore Metro. Area	Washington Metro. Area
1970						
75% Treatment						
5 ppm DO	350	302	545	6	62	47
4 ppm DO	262	226	407	5	46	35
80% Treatment						
5 ppm DO	280	242	416	5	50	37
4 ppm DO	209	181	311	4	37	28
1980						
80% Treatment						
5 ppm DO	316	273	562	6	64	49
4 ppm DO	236	204	421	4	48	37
95% Treatment						
5 ppm DO	79	68	141	2	16	12
4 ppm DO	59	51	105	1	12	9
2010						
90% Treatment						
5 ppm DO	243	197	676	4	75	47
4 ppm DO	182	147	505	3	56	35
95% Treatment						
5 ppm DO	122	98	338	2	37	23
4 ppm DO	91	74	253	1	28	17

expected on even half of the days of a year. We have adopted for this report a definition of supply which comprises that level of freshwater flow in all streams of each region which is to be expected at least 95 percent of the time. In addition we have indicated the best available estimates of the amount of groundwater in each region which may be pumped out continually over the long run. The estimates of streamflow supply are shown in Table 6, along with the total mean streamflow for each region, and an alternative measure of available flow; Table 7 gives groundwater estimates.

TABLE 6

Aggregate Stream Flows, by Maryland Regions (m.g.d.)
Means and Alternative Low Flows

Region	Mean Flows of Record	Flow Equaled or Exceeded 95 Percent of Time	7 Consecutive Day Mean Flow with 10 Year Recurrence
I. Southern Maryland			
Streams leaving Region	355.2	31.1	24.7
II. Western Maryland			
Streams North of Potomac	2,286.1	258.6	159.7
Streams South of Potomac	4,162.4	557.8	287.2
Ohio Basin Drainage	667.8	87.8	46.1
III. Baltimore Metropolitan			
Streams leaving Region	1,567.1	475.9	315.8
Susquehanna River flow	27,187.0	3,262.0	2,229.3
IV. Washington Metropolitan			
Streams leaving Region	576.1	79.4	35.7
V. Eastern Shore			
Streams leaving Region	1,659.8	314.8	192.4

Where the 95 percent streamflow level is not sufficient to meet projected requirements for consumptive uses and quality maintenance flows, storage may be built to impound high flows and release during low flow periods, thus raising the available supply. Figure 1 shows the cost of

TABLE 7

Groundwater Supplies by Maryland Regions

Region		Supply (m.g.d.)	Source of Data
I.	Southern Maryland	324[a]	Bulletin #15, Maryland Department of Geology, Mines and Water Resources
II.	Western Maryland	95	Vol. VII, Corps of Engineers' Potomac River Basin Report
III.	Baltimore Metropolitan	200	Vol. VII, Corps of Engineers' Potomac River Basin Report (Estimated portion of Maryland Coastal Plain supply lying in Prince George's County)
IV.	Washington Metropolitan	200[b]	Bulletin #26, Maryland Department of Geology, Mines and Water Resources Bulletin #4, Maryland Department of Geology, Mines and Water Resources
V.	Eastern Shore	960[c]	Bulletin #18, Maryland Department of Geology, Mines and Water Resources Bulletin #16, Maryland Department of Geology, Mines and Water Resources Bulletin #21, Water Resources of Cecil, Kent, Queen Anne's Counties

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a. An estimated 8.5 m.g.d. is now being pumped.
b. An estimated 40 m.g.d. is now being pumped.
c. An estimated 26.5 m.g.d. is now being pumped.

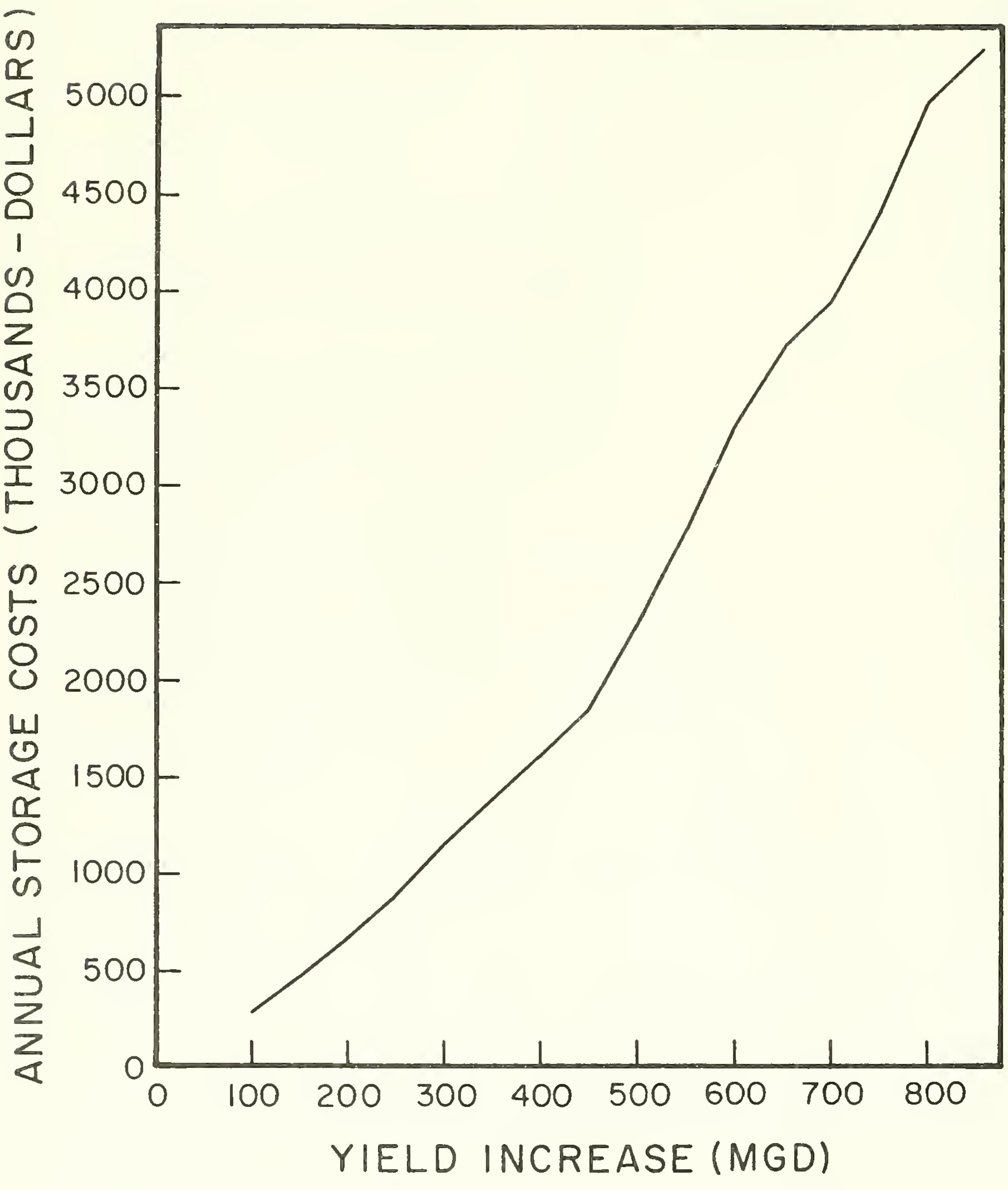

Figure 1

Cost Curve for Yield Increases, Potomac Basin

increasing flows by specified amounts in Western Maryland.

F. Comparing supply and demand by region

Choice is a governing factor in our discussion of meeting Maryland's future water demands. Because uncertainty underlies various aspects of this study, the framing of a single prescription for meeting water demands is neither possible nor desirable. The best policy depends in large part on decisions by the public and their representatives - decisions, for example, on the quality standards to be met by streamflows, the extent to which costs of quality maintenance are to be borne by the public rather than private interests. We therefore present ranges of demands under varying conditions and attempt to specify the monetary costs of alternative public policies. These demands for each region are compared with corresponding supply estimates in Tables 8 to 12, while Table 13 gives estimates of the annual costs of treating wastes and constructing reservoirs under varying conditions.

Briefly, this study indicates that for two regions, the Eastern Shore (Region V) and three Southern Maryland counties (Region I), anticipated consumptive water uses and quality maintenance should not constitute a serious problem even by 2010, although increased use of groundwater in both areas will be required. In the Baltimore Metropolitan Region (Region III), severe deficiencies may be expected by 2010, due mainly to anticipated sharp increases in consumptive uses; however, these deficiencies can be met adequately by flows of the Susquehanna River if upstream users in that basin do not pre-empt more than some 70 percent of flows.

Western Maryland (Region II) may face rather small deficiencies even in the near future, although the existence and extent of these deficiencies will be determined largely by particular combinations of policies and conditions. Relatively small amounts of storage could meet region-wide needs,

TABLE 8

Demand and Supply Balances Projected, Region I, Southern Maryland

(millions of gallons per day)

	1970	1980	2010
Incremental Consumptive Uses	8.5	27.8	76.5
Quality Flow Requirements	0	0	0
Total Demand	8.5	27.8	76.5
Supply (95% streamflows)	31.1	31.1	31.1
Deficiency*	0	0	45.4
Groundwater-Unused Potential	315.5	315.5	315.5

Deficiency equals demand minus supply when this quantity is positive; it equals zero when this quantity is negative.

TABLE 3

Demand and Supply Balances Projected,
Region II (by sections) Western Maryland
(millions of gallons per day)

	1970				1980				2010			
	4 ppm		5 ppm		4 ppm		5 ppm		4 ppm		5 ppm	
	Low Treat	High Treat	Low Treat	High Treat	Low Treat	High Treat	Low Treat	High Treat	Low Treat	High Treat	Low Treat	High Treat
North of Potomac-												
Incremental Consumptive Uses												
A. Maryland	3.2	3.2	3.2	3.2	9.5	9.5	9.5	9.5	20.8	20.8	20.8	20.8
B. Pennsylvania	5.8	5.8	5.8	5.8	14.0	14.0	14.0	14.0	24.3	24.3	24.3	24.3
Quality Flow Requirements	479.0	383.0	645.0	516.0	433.0	108.0	583.0	146.0	333.0	166.0	448.0	224.0
Total Demand	488.0	391.0	654.0	525.0	456.5	131.5	606.5	169.5	378.1	201.1	493.1	269.1
Supply (95% streamflows)	258.6	258.6	258.6	258.6	258.6	258.6	258.6	258.6	258.6	258.6	258.6	258.6
Deficiency*	229.4	132.4	395.4	266.4	197.9	0	347.9	0	119.5	0	234.5	0
South of Potomac-												
Incremental Consumptive Uses (Virginia and West Virginia)	12.1	12.1	12.1	12.1	28.8	28.8	28.8	28.8	51.8	51.8	51.8	51.8
Quality Flow Requirements	414.0	331.0	557.0	446.0	374.0	96.0	503.0	126.0	270.0	135.0	363.0	181.0
Total Demand	426.1	343.1	569.1	458.1	402.8	124.8	531.8	154.8	321.8	186.8	414.8	232.8
Supply (95% streamflows)	557.8	557.8	557.8	557.8	557.8	557.8	557.8	557.8	557.8	557.8	557.8	557.8
Deficiency*	0	0	11.3	0	0	0	0	0	0	0	0	0
Potomac Mainstem-												
Incremental Consumptive Uses												
A. Maryland	3.7	3.7	3.7	3.7	9.6	9.6	9.6	9.6	20.9	20.9	20.9	20.9
B. Virginia-West Virginia	4.1	4.1	4.1	4.1	9.6	9.6	9.6	9.6	17.3	17.3	17.3	17.3
Quality Flow Requirements	746.0	570.0	1,005.0	767.0	770.0	193.0	1,037.0	259.0	926.0	463.0	1,246.0	623.0
Total Demand	753.8	577.8	1,012.8	774.8	799.2	212.2	1,056.2	278.2	964.2	501.2	1,284.2	661.2
Supply**	1,024.7	928.7	1,202.0	1,061.7	962.0	764.1	1,112.0	764.1	839.0	719.5	954.0	730.0
Deficiency*	0	0	0	0	0	0	0	0	125.2	0	330.2	0
Ohio Basin Portion-												
Incremental Consumptive Uses	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Quality Flow Requirements	9.0	7.0	12.0	10.0	8.0	2.0	11.0	3.0	5.0	3.0	7.0	3.0
Total Demand	9.1	7.1	12.1	10.1	8.1	2.1	11.1	3.1	5.1	3.1	7.1	3.1
Supply (95% streamflows)	87.7	87.7	87.7	87.7	87.7	87.7	87.7	87.7	87.7	87.7	87.7	87.7
Deficiency*	0	0	0	0	0	0	0	0	0	0	0	0

* Deficiency equals demand minus supply when this quantity is positive; it equals zero when this quantity is negative.

** Supply in the Potomac mainstem is the sum of flows into the mainstem from north and south. This quantity, for both North and South, is the larger of the following amounts: (a) The 95% streamflows minus consumptive use; (b) The quality flow requirements.

TABLE 5
Demand and Supply Balances Projected
Region III, Baltimore Metropolitan Area
(millions of gallons per day)

	1970				1980				2010			
	4 ppm		5 ppm		4 ppm		5 ppm		4 ppm		5 ppm	
	Low Treat	High Treat	Low Treat	High Treat	Low Treat	High Treat	Low Treat	High Treat	Low Treat	High Treat	Low Treat	High Treat
Incremental Consumptive Uses	99.6	99.6	99.6	99.6	283.8	283.8	283.8	283.8	982.2	982.2	982.2	982.2
Quality Flow Requirements	85.0	68.0	114.0	92.0	87.0	22.0	117.0	29.0	103.0	51.0	138.0	69.0
Total Demand	184.6	167.6	213.6	191.6	370.8	305.8	400.8	312.8	1,085.2	1,033.2	1,120.2	1,051.2
Supply (95% flows)	475.9	475.9	475.9	475.9	475.9	475.9	475.9	475.9	475.9	475.9	475.9	475.9
Deficiency*	0	0	0	0	0	0	0	0	609.3	557.3	644.3	575.3
Susquehanna Flow to Bay (95%)	3,262	3,262	3,262	3,262	3,262	3,262	3,262	3,262	3,262	3,262	3,262	3,262
Unused Groundwater Supply	160.0	160.0	160.0	160.0	160.0	160.0	160.0	160.0	160.0	160.0	160.0	160.0

* Deficiency equals demand minus supply when this quantity is positive; it equals zero when this quantity is negative.

TABLE 6

Demand and Supply Balances Projected,
Region IV, Maryland part of Washington, D. C. Metropolitan Area
(millions of gallons per day)

	1970				1980				2010			
	4 ppm		5 ppm		4 ppm		5 ppm		4 ppm		5 ppm	
	Low Treat	High Treat	Low Treat	High Treat	Low Treat	High Treat	Low Treat	High Treat	Low Treat	High Treat	Low Treat	High Treat
Incremental Consumptive Use												
A. Maryland	80.0	80.0	80.0	80.0	169.9	169.9	169.9	169.9	534.3	534.3	534.3	534.3
B. District of Columbia	22.0	22.0	22.0	22.0	34.2	34.2	34.2	34.2	79.9	79.9	79.9	79.9
C. Virginia	49.1	49.1	49.1	49.1	103.0	103.0	103.0	103.0	289.9	289.9	289.9	289.9
Quality Flow Requirements (Maryland)	64.0	51.0	86.0	69.0	67.0	17.0	90.0	23.0	64.0	32.0	86.0	43.0
Total Demand	215.1	202.1	237.1	220.1	374.1	324.1	397.1	330.1	968.1	936.1	990.1	947.1
Supply (components)												
A. Streams in Region	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4
B. Virginia Streams	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
C. Potomac Mainstem	1,016.9	920.9	1,194.2	1,053.9	942.8	744.9	1,093.8	744.9	926.0	681.3	915.8	691.8
Total Supply	1,161.3	1,065.3	1,338.6	1,198.3	1,087.2	889.3	1,238.2	889.3	1,070.4	825.7	1,060.2	836.2
Deficiency*	0	0	0	0	0	0	0	0	0	110.4	0	110.9
Groundwater Supply	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0

* Deficiency equals demand minus supply when this quantity is positive; it equals zero when this quantity is negative.

TABLE 12

Demand and Supply Balances Projected, Region V, Eastern Shore

(millions of gallons per day)

	1970	1980	2010
Incremental Consumptive Uses			
A. Maryland	40.5	112.7	269.7
B. Delaware, Pennsylvania	20.2	45.1	80.9
Total Demand	60.7	157.8	350.6
Supply (95% streamflows)	314.8	314.8	314.8
Deficiency*	0	0	35.8
Groundwater-Unused Potential	933.5	933.5	933.5

* Deficiency equals demand minus supply when this quantity is positive; it equals zero when this quantity is negative.

TABLE 2

Total Annual Costs of Alternative Regional Projections
(Sum of Storage and Treatment Costs in Maryland in Thousands of Dollars)

	1970				1980				2010			
	4 ppm		5 ppm		4 ppm		5 ppm		4 ppm		5 ppm	
	Low Treat	High Treat	Low Treat	High Treat	Low Treat	High Treat	Low Treat	High Treat	Low Treat	High Treat	Low Treat	High Treat
Region I Southern Md.	726.6	764.8	726.6	764.8	1,022.0	1,175.3	1,022.0	1,175.3	2,594.2	2,712.2	2,594.2	2,712.2
Region II Western Md.	2,519.6	2,132.8	3,225.6	2,731.8	3,554.6	3,219.5	4,130.6	3,219.5	10,419.7	9,965.0	12,486.7	9,965.0
Region III Baltimore Metropolitan	19,030.4	20,032.0	19,030.4	20,032.0	25,935.6	29,825.9	25,935.6	29,825.9	60,189.8*	62,925.7*	60,189.8*	62,925.7*
Region IV Washington Metropolitan (in Maryland)	5,160.8	5,432.4	5,160.8	5,432.4	7,156.4	8,229.9	7,156.4	8,229.9	15,290.0	16,165.8	15,290.0	16,165.8
Region V Eastern Shore	5,764.2	6,067.6	5,764.2	6,067.6	7,752.0	8,868.8	7,752.0	8,868.8	16,511.9	17,262.4	16,511.9	17,262.4
State of Maryland	33,201.6	34,429.6	33,907.6	35,028.6	45,420.6	51,319.4	45,996.6	51,319.4	105,005.6*	109,031.1*	107,072.6*	109,031.1*

but the topography, drainage, and population distribution of the area might well require more storage than the minimum suggested. The portion of Maryland adjacent to the District of Columbia (Region IV) is not itself projected to face shortages, but since requirements for the entire Washington Metropolitan area must also be met nearly entirely from Potomac flows, small deficiencies are projected.

The critical role of estuarial quality in a balanced evaluation of the State's water prospects cannot be emphasized too strongly. For example, the U.S. Public Health Service estimates of flows required in the Potomac estuary at Washington range from 1,900 to 2,400 m.g.d. - enough to cause very large deficiencies in Region IV which could only be met by large increases in storage in the upper Potomac Basin, either in Region II of Maryland, or in Virginia, West Virginia, and Pennsylvania. In addition, our projections imply waste discharges to the Chesapeake Bay and its estuaries from Regions I, III, and V, which may well spell serious pollution dangers to waters which are of vital importance to the State economically and aesthetically.

G. Recommendations

This report's broad recommendations will, of course, have to be reevaluated as better information concerning estuarial pollution and its prevention becomes available. With this caveat, the public actions which would be consistent with this study's conclusions are:

1. The requirement of considerably higher average levels of waste treatment than now prevail. Under what we consider to be the most likely future conditions, it appears that the overall least-cost method of meeting needs would require average treatment levels of 80 percent in 1970 and 95 percent in 1980 and 2010. If these levels are deemed unachievable, at least for the earlier decades,

levels of 75 percent in 1970, 80 percent in 1980, and 90 percent in 2010 would be workable (though more expensive) compromises. Although this measure may not be of pressing importance in Regions I and V where wastes after treatment are assumed to be discharged to salt or brackish waters, the dangers of estuary pollution, and the difficulty in administration of a policy which differentiates among regions, make a statewide treatment requirement preferable.

2. The construction of from 60,000 to 440,000 acre feet of reservoir capacity in Western Maryland or the Potomac watershed portion of Pennsylvania, primarily to provide low flow augmentation in the streams which flow into the Potomac from the north. Closer examination (such as that undertaken in the Corps of Engineers study) might well reveal a somewhat larger storage requirement in order to meet needs at specific points within the region, especially in the Cumberland area of Western Maryland.*

3. It would be desirable for the Baltimore Metropolitan Region to have assurance of as much as 750 million gallons per day from the Susquehanna River over and above the 250 million gallons per day to which rights now exist and for which an aqueduct has been constructed.

4. The State of Maryland should continue its study of water management, and should expand the collection and analysis of data on water use and supply. In particular, more information is needed on estuarial pollution, on the quantity and quality of

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* Note that no analysis is made of flood control requirements which are critical in certain parts of Western Maryland.

waste discharges, and on the substitution of capital for water in industrial technologies.

Studies of incentive systems for an improved control of stream pollution should also be undertaken.